Accelerating Digital Transformation

Visual Insights from the API Ecosystem

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Digital transformation is accelerating due to the rapid emergence of open APIs. Using a curated dataset of nearly 15,000 APIs, the author visualizes the structure of the API ecosystem, revealing distinct clusters within it.

Enterprise transformation—which can be broadly defined as the fundamental change in what an organization does and how it does it—is predominantly driven by either *experienced* or *anticipated* value deficiencies.[1] These two deficiencies can result from changes in market conditions (such as new competitors or the growth rate) or customer expectations (such as preferences), as well as innovation or technological disruptions (for instance, new products or technological advancements), among other things.

Today's business landscape is constantly shaped by such value deficiencies. Consequently, the necessity for transformation is a clear business reality. It occurs in all industries and impacts organizations of all sizes and shapes. New players emerge constantly; some incumbents survive while others do not.[2] Supporting evidence for this "creative destruction" is highlighted by the significant reduction in the average lifespan of companies listed on the S&P 500.[3]

Although change has been constant, we are arguably experiencing the most remarkable era of enterprise transformation to date. The confluence of four tectonic technological forces—social, mobile, analytics, and the cloud—is reshaping everything we know about business: that is, how value is organized, created, and delivered in virtually all industries, ranging from banking and transportation to energy and healthcare.[4]

It has been argued that the true building block of this digital transformation is the rapid prominence of APIs.[5] APIs are, in essence, digital control points

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that set the terms for which data and services can be efficiently shared or "called" over the Internet. APIs are not new; they have existed for decades.[6] However, what is new is the ability for anyone to access and reuse them freely. Following principles of open innovation, the idea of APIs is to let others innovate on top of these digital assets, enabling API providers to reap significant benefits, such as the creation of new offerings, access to new markets, and the cultivation of a rich developer ecosystem.[7] Bala Iyer and Mohan Subramaniam have consequently argued that APIs are turning into the most salient form of interfirm partnership.[8] Here, I examine this growing API ecosystem.

The API Ecosystem

According to ProgrammableWeb (www.programmableweb.com), a leading open source directory, there are nearly 15,000 APIs and 7,000 mashups (integrating two or more APIs) in a diverse set of categories. Using various business models, many digital leaders have recognized APIs' economic value and are adopting them at rapid speed. Prominent examples include Google, Amazon, Facebook, Salesforce, Twitter, Uber, and Netflix, all of which handle a staggering number of calls every day.[9] Moreover, a recent study found that APIs generate significant revenue streams for many leading companies, such as Salesforce (50 percent), eBay (60 percent), and Expedia.[10]

However, not all firms are equally active in the API ecosystem; in fact, significant firm-level differences exist. For instance, prior work showed that Amazon has built its entire business around APIs,[11] whereas Walmart offers only a few. Why is this the case? A recent survey of global businesses found that strategy, not technology, drives digital transformation.[12] Enterprises that embrace a comprehensive digital strategy and take technological risks become digital transformation leaders. Moreover, API strategies will differ depending on the type of role a company plays or wants to play in the ecosystem. This holds particularly true in the API ecosystem.

Consider a few examples. Google Maps, one of the earliest public API releases, can be found in many applications that include a geospatial aspect. More recently, Google announced API access to its machine learning platform, a move some are suggesting will not only create novel intelligence applications, but will transform the entire cloud computing market. Amazon offers a comprehensive API portfolio ranging from cloud storage to marketing analytics. Uber ride requests can now be made via Facebook. OpenTable reservations are available through the FourSquare app. All of these providers are considered digital leaders in their respective industries. Walmart, on the other hand, offers a limited number of open APIs, suggesting a divergent digital strategy for value enablement and recombination.

Although prior work has provided insights into other firm-level differences,[11] less is known about API strategies across different market segments. How are different segments shaping the strategic transformation of the API ecosystem? What market segments cluster together? Which ones are more peripheral? And what API segments are (re)combined to create new offerings? In this study, I aim to provide answers to these questions using a data-driven visualization approach.[13] In doing so, it contributes to a theoretical understanding of industry transformation through digital technologies. Managerially, this analysis provides insights into the structure of the emerging API economy and potential suggestions for corporate API strategies.

Methodology

Using a curated dataset of 14,849 APIs and 6,276 mashups in 455 categories from 2005–2016, my colleagues and I at the Georgia Institute of Technology first constructed a category-to-category network in which nodes represent API categories, and edges between two nodes represent whether an API/mashup was tagged using the two categories. Edges are scaled proportionally to the total number of category co-occurrences, thereby indicating the level of co-use of the API categories.

Next, we computed salient network properties, including various centrality and modularity measures, to understand the position, prominence, clustering, and influence of categories in the API ecosystem. We then visualized this network in Gephi (www.gephi.org)[14] using a cluster-emphasizing, force-directed layout algorithm (OpenORD);[15] identified and color-encoded subcommunities in this network using a modularity-based approach;[16] and sized nodes according to their influence.[17] To improve readability and aesthetics, we applied a no-overlap algorithm to spread nodes apart.[18] We used a human-centric approach to label each subcluster, manually

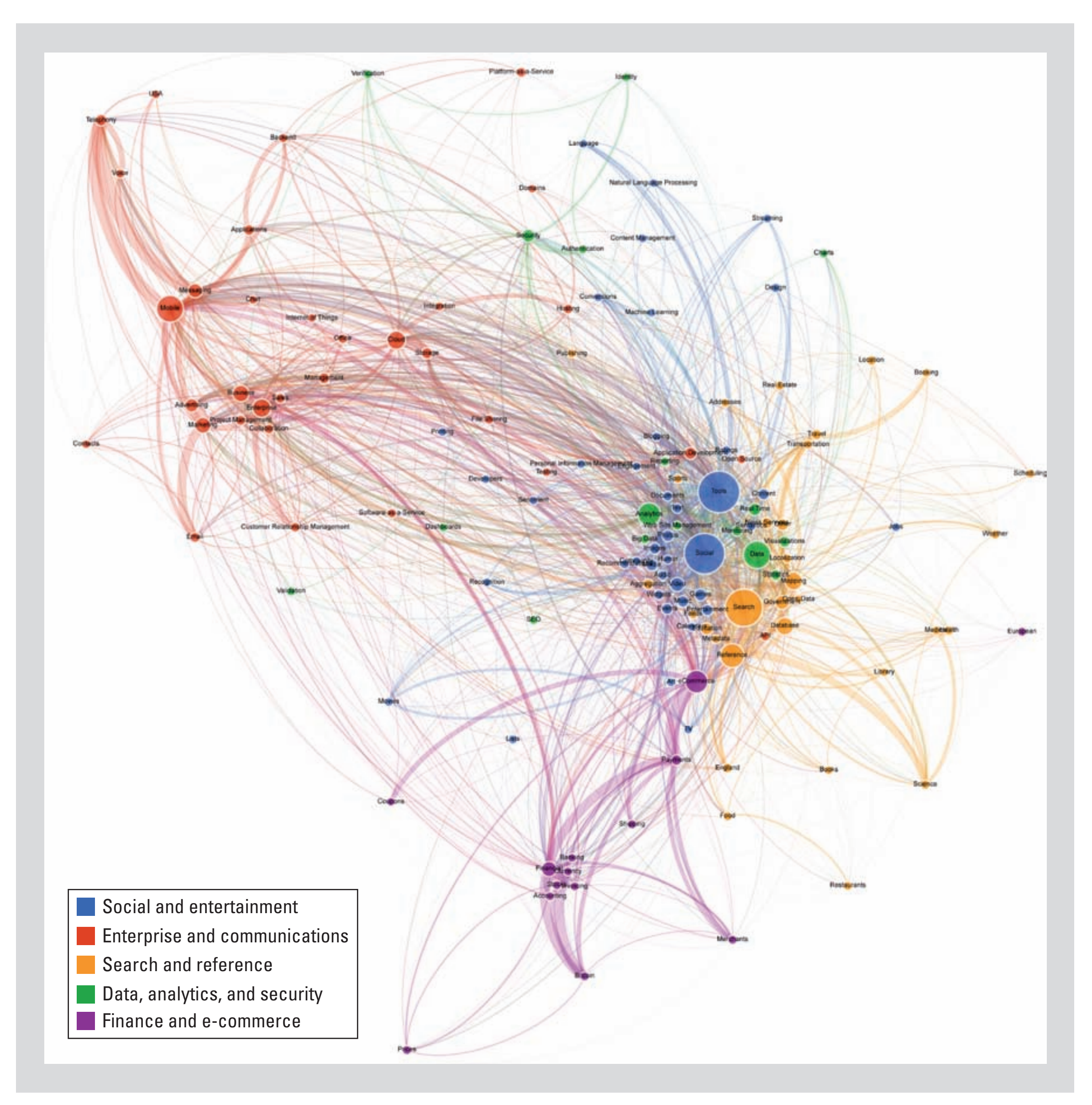


Figure 1. **Visualization of the API category ecosystem. At the core of this ecosystem are the social, search, and tools categories.**

inspecting the description of categories and then creating meta-labels. By visualizing the network and color-encoding the substructures, valuable insights into the overall structure of the underlying ecosystem can be gained.[19]

Findings

To provide the core picture of the API category ecosystem and reduce edge clutter, we filtered the network by a minimum degree (≥25) and edge weight (≥2). This left 135 categories (29.67 percent) and 2,798 edges (18.83 percent) in the ecosystem. Figure 1 shows the ecosystem visualization. Several interesting observations can be made. First, five broad subclusters can be identified, as encoded by color:

1. social and entertainment (29.6 percent);
2. enterprise and communications (24.4 percent);
3. search and reference (22.9 percent);
4. data, analytics, and security (12.6 percent); and
5. finance and e-commerce (10.4 percent).

However, there is a dense core consisting of a mix of API categories from subclusters 1, 3, and 4. At the core of the entire API ecosystem are *social*,

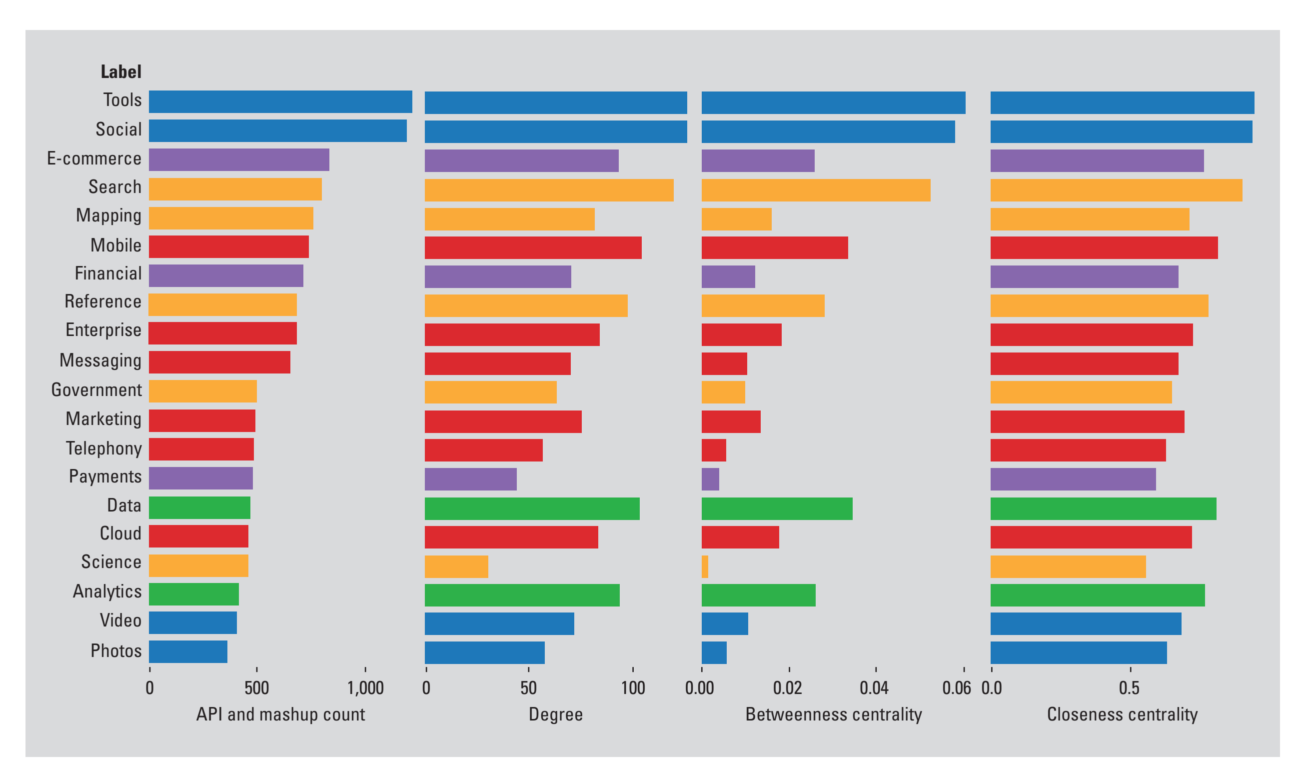


Figure 2. Top 20 API categories sorted by API and mashup count and structural metrics. Subcluster 1 categories (tools and social) occupy the top two spots, suggesting that these categories are not only popular but also complement almost all other API categories.

search, and *tools*, indicating the importance of these capabilities to digital services in general. Interestingly, *analytics*, *data*, and *visualizations* all intermix with this core, suggesting growth toward data-driven insight capabilities. Connecting this core to the finance subcluster is *e-commerce*. *Bitcoin* is much more peripheral to it all and loosely connected to *merchants*. Rather surprisingly, the enterprise and communications subcluster at the top of the figure is somewhat removed from most of the ecosystem. However, *cloud*, *storage*, and *mobile* appear to connect to much of the API ecosystem. What's interesting is the bridging position of *security* and *authentication* APIs between the enterprise, social, and finance subclusters.

Figure 2 lists the top 20 main API categories sorted by API and mashup count and three key structural metrics: *degree*, *betweenness centrality*, and *closeness centrality*. Degree refers to the number of total links in a category. Betweenness centrality refers to how central a category is when considering any two categories in the API ecosystem. Categories with high betweenness centrality most likely act as bridging categories and can thus become information conduits for different categories. Closeness centrality measures how near a category is to everyone else. It could thus be perceived as a potential proxy for API complementarity to the ecosystem.

The results show that subcluster 1 categories (*tools* and *social*) occupy the top two spots. This result suggest that these API categories are not only popular but also complementary to almost all other API categories. In other words, they are used frequently to create new value. *E-commerce* and *financial*, while not very large categories, are also in the top 10, indicating their importance to digital services in general. One interpretation of this result could be that many of the digital services that are recombined involve some economic transaction; these two API categories facilitate these transactions. These categories are followed by *search* and *mapping*, which are particularly important in an increasingly data-driven and geospatial world. For instance, many if not all transportation and social-related applications incorporate a geographic component. Similarly, many consumer-oriented applications require strong search capabilities to allow users to quickly find relevant information. Another interesting

observation is the particularly high centrality scores of both *data* and *analytics* APIs, suggesting the high complementary value of both categories to other APIs in the digital ecosystem.

This analysis has several managerial implications. First, the API ecosystem exhibits a core-periphery structure, highlighting that some categories are well-established and essential to digital value creation and combination, while others are clearly still emerging. Companies that want to play a central enabling role in the digital ecosystem must thus consider offering APIs in those core segments. Second, although barriers of entry in offering APIs can be low, competition in these categories can be particularly high. To become a key enabler, a clear and differentiated value proposition in these core categories is needed. Third, peripheral API categories present areas of value emergence, opportunity, and niche. Although not integral yet, these categories might become more important over time. Taking these findings as a whole, we speculate that companies must carefully devise—perhaps even balance—an appropriate API portfolio of both core and peripheral APIs corresponding to their desired role in the digital ecosystem.

As enterprises become increasingly hyperconnected, appropriately crafted API strategies will become essential to ensure survival, innovation, and growth.[20] This study revealed that some categories are more prominently positioned in the API ecosystem than others. Note that this represents only a snapshot in time. Analytics-related APIs, for instance, will play an important role in all aspects of the ecosystem. While still-sparse health-, wellness-, and medicine-related APIs are not part of the core ecosystem, we anticipate that they will increasingly connect with social and mobile APIs. Decision makers must embrace the complex relationships among various segments to understand their position in the ecosystem and identify possible opportunities for new collaboration and innovation. IT

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